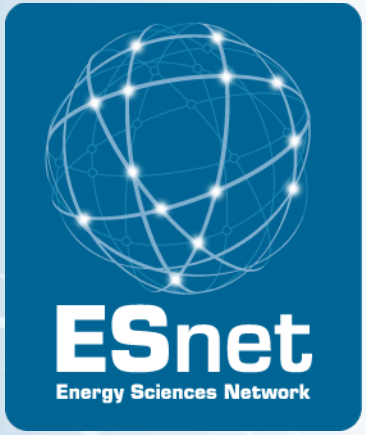


DOE's Advanced Network Initiative (ANI) Testbed Project Update

Brian Tierney, Staff Scientist

ESnet

January 12, 2012

Overview

Testbed Value

Testbed Overview

Current Testbed Research and Results

Testbed Future

Testbed Value

- A realistic national-scale environment for innovative network research that would be impossible for most researchers to create in their labs
  - Many types of network research require realistic high-latency environments
- Maximum flexibility: researchers get “super-user” access to everything
  - ability to install custom OS on hosts
  - ability to do full routers/switch configuration
  - ability to install custom router software
- A controlled environment that supports reproducible results

Priority is given to research that aligns with ESnet strategic focus areas, such as:

- High performance network protocols, data transfer middleware, Openflow + MPLS integration strategies, energy efficient networking

Testbed Components

The ANI Testbed is really 3 separate Testbeds, each focused on different types of research

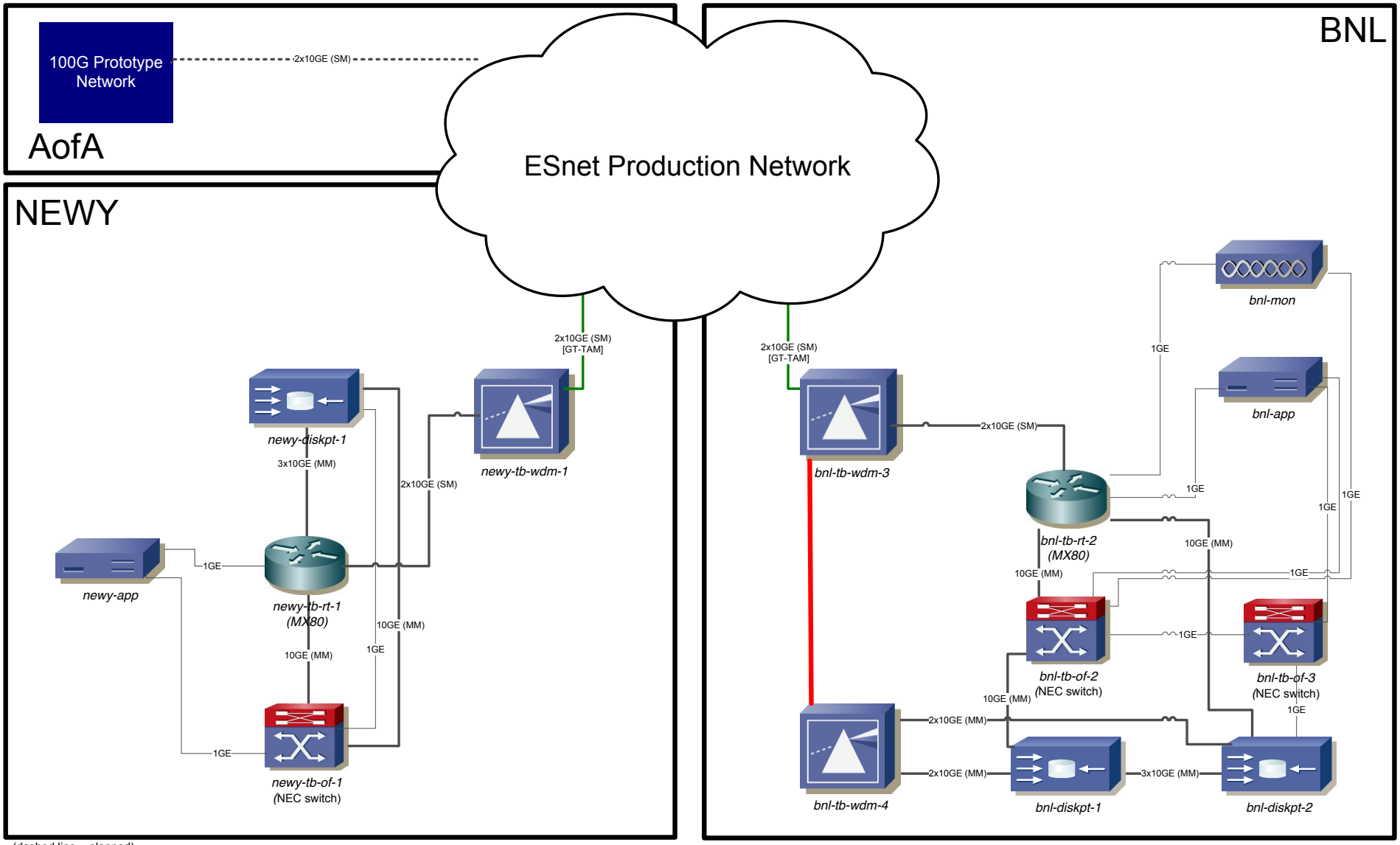
- Control Plane Testbed
- 100G Testbed
- Dark Fiber Testbed

Control Plane Testbed

Control Plane Testbed

- 700 KM loop on Long Island Between Manhattan and Brookhaven National Lab
- Infinera DWDM switches, NEC OpenFlow switches, Juniper router (soon with OpenFlow support), 6 hosts
- Research Examples
  - OpenFlow experiments
  - Path Computation algorithms
  - MPLS/OpenFlow Integration

Long Island MAN (LIMAN) Testbed Architecture



(dashed line = planned)

Updated July 8, 2011

Notes:
-"App Host": can be used for researcher application, control plane control software, etc. Can support up to 8 simultaneous VMs
-"I/O Testers" are capable of 15 G disk-to-disk or 35G memory-to-memory
-Other infrastructure not shown: VPN Server, file server (NFS, webdav, svn, etc.)

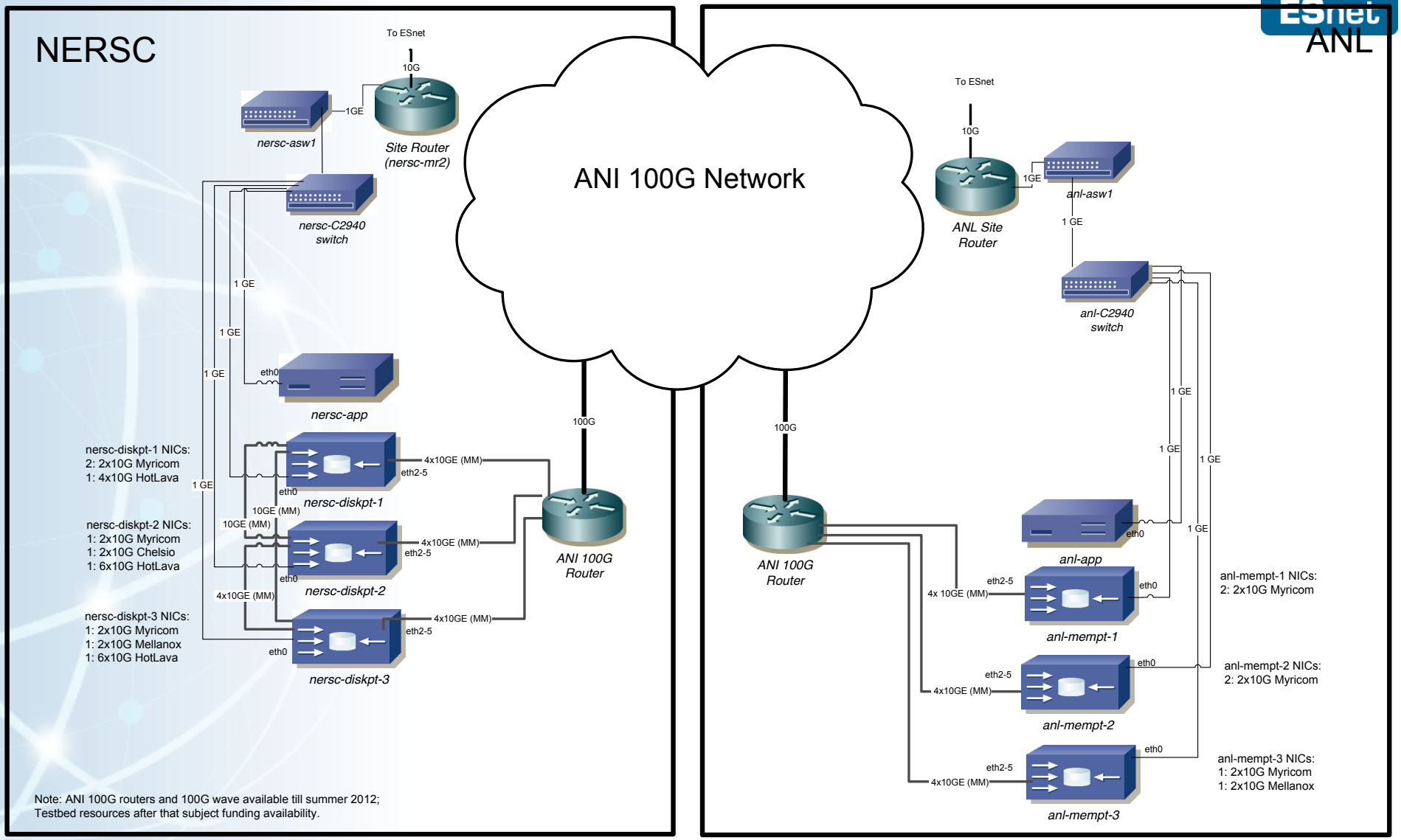
100G Testbed

100G Testbed

- 100Gbps path from Oakland, CA (NERSC) to Argonne, IL (ANL)
- 3 high-end hosts at each site, capable of >39 Gbps each
- Research Examples
  - 100G data transfer tools
    - FTP100, GridFTP, BestMan, Saratoga
  - TCP alternatives
    - RDMA, RoCE
  - TCP enhancements
    - PERT, RAPID TCP

Available as of Jan 3, 2012

ANI Middleware Testbed



Related Resources

Magellan at NERSC

- 8 nodes with 2x10GE, GPFS backend

Magellan at ANL

- 16 nodes, but going away very soon

ORNL test cluster

- 12 nodes, LUSTRE backend

FNAL test cluster

- in planning stage

Dark Fiber Testbed

Dark Fiber Testbed

- Nationwide footprint (13,000 miles)
- Researchers must pay to light the fiber, but no charge for access if results will be public
- Research Examples
  - Greentouch Energy experiments
  - JPL quantum networking / quantum cryptography experiments

Dark Fiber Network

LBNL Long Haul Dark Fiber Routes
12,924 miles

BayExpres Metro Fibers: 432 miles
ChiExpress Metro Fibers: 167 miles
NYExpress Metro Fibers: 6 miles

Current ANI Testbed Research

25 projects have been accepted to the testbed so far:

- 8 via direct DOE/ASCR funding
- 17 via testbed proposal review process
- 5 from Industry; 8 from DOE labs; 3 from NASA, 1 from DISA, 7 from Universities

Wide range of projects:

- 9: high-speed middleware
- 3: OpenFlow
- 4: other network control plane
- 1: 100Gbps end host hardware
- 1: network flow classification
- 1: quantum communications
- 2: Wide Area RDMA
- 2: TCP congestion control
- 1: security
- 1: energy efficiency

http://www.es.net/RandD/advanced-networking-initiative/current-testbed-research/

Potential Breakthroughs from Current Testbed Research

Unconditionally secure continuous variable quantum communications

Ability to scale TCP well beyond 10Gbps

Alternative transport protocols that scale better than TCP (e.g.: RDMA)

Ability to easily create end-to-end circuits

Ability to scale data transfer tools/middleware to 100Gbps and beyond

100Gbps host interface

For more information see:

http://www.es.net/RandD/advanced-networking-initiative/current-testbed-research/

Results to Date: Publications Submitted

After only 7 months of being operational, there are already several publications submitted based on ESnet's Testbed results:

- *Energy Profiling of Network Elements for Rate Adaptation* Technologies, M. Ricca, A. Francini, S. Fortune, T. Klein, submitted to the ACM/IEEE 3rd International Conference on Future Energy Systems (e-Energy 2012).
- *Traffic engineering in hybrid IP/optical circuit networks*. Zhenzhen Yan, Chris Tracy, and Malathi Veeraraghavan, submitted to the IEEE 13th Conference on High Performance Switching and Routing (HPSR)
- *Middleware Support for RDMA-based Data Transfer in Cloud Computing*, Yufei Ren, Tan Li, Dantong Yu, Shudong Jin, and Thomas Robertazzi, submitted to IEEE International Parallel & Distributed Processing Symposium (IPDPS)
- *Identifying gaps in Grid middleware on fast networks with the Advanced Network Initiative*, G. Garzolglio and Dykstra, accepted at International Conference on Computing in High Energy and Nuclear Physics (CHEP 2012)

Results to Date: Press Releases

Joint Press Release by Orange Silicon Valley, Bay Microsystems and ESnet on the first wide area 40G RDMA results (http://goo.gl/57gSJ)

- Showed that RDMA moves data at up to 96 percent of the peak capacity of the network
  - Much more efficient than TCP
- Replicated at SC11 over a 10,000KM path (http://goo.gl/ZE0w8)

Greentouch press release on plans to use ESnet dark fiber testbed for energy experiments: http://goo.gl/OB6nD

Results to Date: Demonstrations

- ESnet Demonstration of OSCARS/OpenFlow integration on the ANI testbed at the Open Networking Summit held at Stanford.
  - http://goo.gl/4FFBg
- ESnet Demonstration of 9.9Gbps RDMA transfers from the ANI Testbed at BNL to Seattle at SC11

Results to Date: Industry Involvement

- Loaner hardware for 40GE testing
  - Infinera, Alcatel-Lucent (ALU), Bay Microsystems, Mellanox

Future Testbed Challenges

Long term operational support of the Testbed

- Current testbed funding will run out in August of this year
  - Currently funded at 2FTE for testbed support
    - This is essential for continued success

Hope to secure funding to ensure persistent/indefinite availability

- 100G wave from NERSC to ANL will transition to production use starting this summer, so need to identify funds to light a 2nd wave for testbed use

Dark Fiber will be available to the testbed until it is needed for production use

- For some segments this may not be for several years.

More Information

http://sites.google.com/a/lbl.gov/ani-testbed/

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